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(54) **Dosing pump.**

(57) A dosing pump comprising a pump housing (48) which has a cylindrical feed piece (120) extending into the housing (48), a first hollow piston (82) in the pump housing (48) provided with a stem (68) having an axial outlet channel (98) forming a valve seat (158), a second piston in the pump housing (48) which consists of two parts (150, 190), of which one part has a piston skirt (202) and, with the tubular feed piece (120), forms an inlet valve for the liquid flowing from the container into the pump chamber (80) and of which the other part has a rod (162) interacting with said valve seat (158) to form an outlet valve. The two parts (150, 190) of said second piston interact through a return spring (240) arranged between said second piston (190) and said housing (48). The individual part of the pump reliably expose a passage between container and pump chamber. The parts can be reliably and quickly produced by an injection moulding process for plastics and it is achieved a simple and quick assembly of the dosing pump for the purpose of industrial mass production.

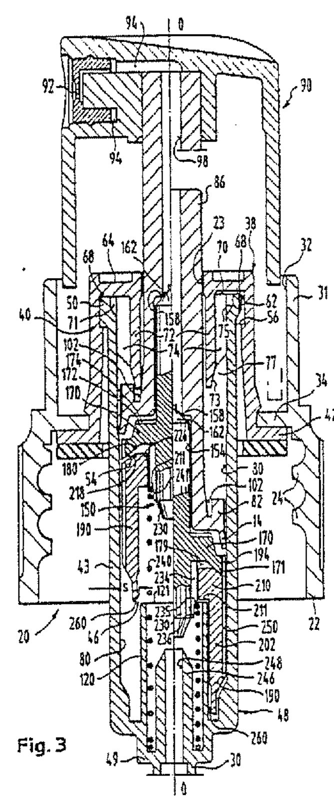

Fig. 3

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Dosing pump

The invention relates to a dosing pump for atomizing a liquid, which dosing pump is contained in a container and in which the following parts are arranged on a common rotational axis:

- a pump housing is connected to the container by a cylindrical, open tubular feed piece which extends into the interior of the pump housing,
- a first hollow pump piston is displaceably arranged in the interior of the pump housing, the pump piston to seal off a pump chamber in the interior of the pump housing from the atmosphere, bearing tightly against the inner wall of the pump housing as well as being provided, on the side remote from the container, with a hollow piston stem having a narrowed inner cross-section of an axial outlet channel as a valve seat,
- a second differential piston which is displaceably arranged in the interior of the pump housing and, on the side facing the container, is provided with a piston skirt whose one free end can be pushed in a sealing manner onto the open tubular feed piece of the pump housing to close the pump chamber from the container, and, on the side remote from the container, with a valve rod, engages into the hollow piston stem of the pump piston and interacts with the valve seat located therein to form an outlet valve for the delivery of the liquid contained in the pump chamber into the atmosphere,
- a return spring which is arranged between the differential piston and the pump housing and which overlaps a guide pin and bears against the latter, which is provided on the side of the differential piston facing the container, the differential piston consisting of two parts, of which one part has the piston skirt and, with the tubular feed piece, forms an inlet valve for the liquid flowing from the container into the pump chamber.

Dosing pumps of this type of construction are being demanded more and more often by the cosmetics and pharmaceutical industry so as to be able to offer liquids in the form of aerosols. In fact, a dose of the liquid contained in a supply container can be atomized every time by these pumps without using a compressed gas irrespective of whether the latter is dissolved in the liquid, such as freon, or whether it occupies the space in the container above the liquid, such as nitrogen. The liquid is atomized by means of pressure pistons solely by manual actuation. This type of construction not only appears more reasonable with regard to environmental protection and safety but is also more economical inasmuch as preparation of the liquids which can be realized in this way is simpler. This is because it is unnecessary in this case to introduce gases under high pressure, e.g. 6 to 10 bar, into the already closed container or to protect the latter from the effect of heat.

F-A 2,133,259 discloses a dosing pump of the abovementioned generic category which is especially effective but relatively inexpensive to manufacture. The construction of the most commonly used version of this dosing pump is described in detail following the brief description of the drawings with reference to Figs. 1 and 2. This known dosing pump is composed of only three movable parts. Furthermore, these parts, despite the small dimensions, can readily be produced by the injection molding process. As far as their use is concerned, a liquid dose can only be atomized with this type of pump if the operator exerts a sufficiently high pressure on the pistons. This avoids undesired leaking of the liquid or the discharge of an insufficiently atomized liquid jet. The associated system offers greater functional capacity, e.g. related to the position or inclination of the container or the frequency of use.

In this dosing pump, the delivery of the aerosol, as in every pump, is achieved by reducing the volume of the pump chamber by means of the pressure pistons which the operator has to press down against the resistance of a return spring. The return spring then provides for the return of the pistons into the initial position and for the increase in the volume in the pump chamber. This increase in volume takes place while the pump chamber is sealed off from both the outer atmosphere and the container having liquid to be atomized. Consequently, a relatively powerful vacuum develops in the pump chamber. On the one hand, this vacuum naturally helps to refill the chamber when, after the piston has returned almost completely into the initial position, a connection is finally made between the pump chamber and the interior of the container. On the other hand, however, it also entails several disadvantages. First of all it is absolutely essential to effectively seal off the pump chamber from the ambient air. If the seal is inadequate, the vacuum in the chamber tends to draw in air. As a consequence there-of, the greater the air quantity already drawn in, the smaller is the amount of liquid which passes into the chamber. Therefore pumps already known are in many cases provided with a double sealing lip. This in turn necessitates the presence of a sufficiently powerful return spring which returns the pressure pistons into the initial position despite friction at the double lip. When actuating the pressure pistons, therefore, the operator must compress this spring and in the process apply a relatively large amount of force. Consequently, children often have difficulty in operating

such pumps. In addition, the double lip is continuously loaded. Since it is made of plastic, that is, of a material subject to plastic flow, the tight contact produced by the sealing lip becomes less and less as the age of the pump in-creases. After some time, therefore, the phenomenon of the intake of air into the chamber, even if it was initially prevented by the double lip, finally occurs anyway. This effect intensifies in the course of time so that the quantity of liquid passing into the chamber continues to decrease. Since this quantity is nothing but the liquid dose atomized when the pump is actuated, the dose delivered in each case changes each time. This is troublesome in particular in atomizers for pharmaceutical preparations where an accurate dosage is important.

Furthermore, dosing pumps are already known whose design is supposed to remove the disadvantages of a connection between the pump chamber and the container only after the pressure pistons have returned almost completely into their initial position. Common to all these proposals is the capacity to expose a passage between the interior of the container and the pump chamber at the very beginning of the piston return. This passage is closed during the downward movement of the pressure pistons and the reduction in the pump-chamber volume associated therewith, thus ensuring that the liquid is suitably compressed for the atomization. As a rule, this is achieved by fitting check valves. Some of them are simple check valves and work with ports which are provided in the pistons acting as a separating element between the pump chamber and the container, these ports being closed on the side facing the pump chamber. This can be done by means of a movable element such as a cap (US patent specification 4,089,442), a collar (French patent specification 2,433,982), a gap-shaped bore (French patent specification 2,558,214) or a flexible seal. These check valves are relatively unreliable or contain a polymer component which threatens to decompose in contact with certain liquids. European patent specification 0,289,855 discloses a further type of check valve. This check valve type is distinguished by the fact that the pressure piston acting as a separating element between the pump chamber and the container consists of two parts which are connected to one another via a lost-motion connection in such a way that alternatively either a channel opens between them or they bear against one another gastight. However, realizing these extremely small (in millimeter range) parts causes a problem in the injection molding of the claws and grooves required for the lost-motion connection. Furthermore, for the purpose of industrial production, the small parts prove to be problematic during assembly.

The object of the invention is to improve a dosing pump as defined in the preamble of claim 1 in such a way that the individual parts of the dosing pump, in their capacity to reliably expose a passage between container and pump chamber at the very beginning of the piston return, are formed simply and optimally and consequently can be reliably and quickly produced by the injection molding process for plastics, and a simple and quick assembly of the dosing pump is ensured for the purpose of industrial mass production.

This object is achieved by the invention in that the two parts interact through an interposed return spring.

The two parts forming the differential piston are both formed in such a way that they can easily be produced by the injection molding process by not having any projections which inevitably have to be released from the injection molds or which would necessitate complicated opening mechanisms for the injection molds. In addition, assembly can be effected by successively lining up the parts which form the stepped piston in the interior of the pump housing.

The sub-claims contain convenient further developments of the invention.

In order to more clearly illustrate the use of the further-developed atomizing/dosing pump according to the invention as well as the functional improvements resulting therefrom, an exemplary embodiment is described below by means of drawings. Despite the clarity of these drawings, the further development concerned here is not restricted to the configuration of the parts shown here. On the contrary, the drawings are intended to put in concrete terms the substance of the invention, which is better defined in the concluding claims. In the drawings:

Fig. 1 shows the sectional elevation of an exemplary embodiment of an atomizer having a known dosing pump in the inactive position,

Fig. 2 shows the dosing pump according to Fig. 1 directly after the atomization of a liquid dose,

Fig. 3 shows a dosing pump according to the invention in sectional elevation, the various parts of the atomizer being shown to the left of the center longitudinal axis of the pump in the inactive position and to the right of the center longitudinal axis of the pump after the atomizing operation,

Figs. 4 and 5 show a detail of the second two-piece stepped piston of the dosing pump shown in Fig. 3.

Before the dosing pump according to the present invention is described in greater detail, the description will first of all deal with an exemplary embodiment of the known dosing pumps to which the improvement according to the invention relates. In this respect, reference is made to Figs. 1 and 2.

These figures, in longitudinal section, show a plurality of parts which are predominantly made of relatively hard plastic. They illustrate the rotational symmetry of the various elements forming the atomizer with regard to the center longitudinal axis OO. Accordingly, the dosing pump 20 in Figs. 1 and 2 consists of a container 26 which contains the liquid to be atomized, it being assumed from the outset that atmospheric pressure prevails in the container 26, and furthermore consists of a closure cap 22 which can be screwed gas-tight onto the container 26 by means of a seal 41; a holder 38 which is held against the seal 41 by a radial annular flange 34 of the closure cap 22; a pump housing 48 whose exterior is formed by a cylinder 43 which surrounds a pump chamber 80 and whose upper end, with an annular flange 42, is snapped into place inside the holder 38 and whose lower or inner end terminates in a nipple 30 which accommodates a dip tube (not shown) extending down approximately to the bottom of the container; a hollow pump piston 51 which bears against the holder 38 and is displaceable gas-tight in the interior of the pump housing 48 at least over part of its stroke and whose hollow piston stem 86, which is dimensioned so as to be smaller in diameter, is guided in the inner shell 72 of the holder 38; and also an actuating device 90 as an upper closure for the piston stem 86 of the piston 51, which actuating device 90 is guided in an axially displaceable manner in the closure cap 22 and has on one side a nozzle 28 provided with a spray opening 92 for laterally spraying the liquid in aerosol form.

Furthermore, the pump housing 48 encloses a second piston, namely a skirt-type piston 16 which is designed in a very specific shape. Protruding axially upward from its upper end is a solid cylindrical valve rod 61 which ends in a valve cone 162, protrudes into the piston stem 86 of the pump piston 51 and also bears against an inner narrowed section of the piston stem 86 in the form of a valve seat 158. The other end of the skirt-type piston 16 is formed by a cylindrical piston skirt 17 which is guided on the inner wall of the pump cylinder 43. Inside the piston skirt 17, the skirt-type piston 16 has a guide pin 44 coaxial to the main axis OO of the atomizer. A cylindrical helical compression spring 9 arranged coaxially to the axis OO is supported and centered with one end on this guide pin 44. In the embodiment shown in Figs. 1 and 2, the other end of the spring 9 is supported on the base 49 of the pump housing 48. So that the spring 9 can be satisfactorily guided and held without impairing the axial compression, the lower end of the helical compression spring 9 is supported inside an annular space 18 on the base 49 of the pump housing 48. This annular space 18 is formed on the one side by a cylindrical guide pin 246, coaxial to the main axis OO and protruding into the pump chamber 80, and also by a cylindrical tubular feed piece 120 coaxial thereto.

Without an external force effect, the abovementioned parts are allocated to one another as shown by Fig. 1. In order to explain the mode of operation of this known dosing pump, it is assumed that the pump chamber 80 formed by an annular space 45 between the pump cylinder 43 and the tubular feed piece 120 is filled with liquid. The pump chamber 80 here has its greatest extent, since the helical compression spring 9 presses against the skirt-type piston 16, which in turn acts upon the pump piston 51 and presses it upward. In this arrangement, every connection between the interior of the container 26 and the external surroundings is interrupted. On one side, the valve cone 162 of the valve rod 61 of the skirt-type piston 16 sits on the valve seat 158 of the piston stem 86 of the pump piston 51 and thereby closes off an outlet channel 98 from the atmosphere. The relative elasticity of the parts ensures that the outlet valve 158, 162 is sealed off. On the other side, the pump piston 51 bears tightly against the inner shell 72 of the holder 38.

When a thrust force F is applied to the actuating device 90 so that the resistance of the helical compression spring 9 is overcome, a plurality of successive actions take place until finally the configuration of the parts which is shown in Fig. 2 is obtained. First of all the contact between the pump piston 51 and the inner shell 72 of the holder 38 is broken. From this moment on, the container 26 is in connection with the ambient air, and in fact in particular by means of an annular gap 33 between the holder 38 and the piston stem 86 of the pump piston 51 and also various recesses 55 arranged on the inner shell of the holder 38. As will be described below, this connection with the outside air exists as long as the pump is actuated. For this reason the tightness of the contact point between the pump piston 51 and the pump housing 48 is important. It is ensured here by the bearing of two sealing lips 12, 14 against the wall of the pump cylinder 43, which sealing lips 12, 14 are disposed in opposite directions and are carried by the pump piston 51. The lower margin of the piston skirt 17 of the skirt-type piston 16 overlaps the tubular feed piece 120, which protrudes coaxially into the interior of the pump housing 48. This ensures that the liquid originally contained in the pump chamber 80 of the dosing pump 20 is closed off, and in fact again on account of the relative elasticity of the parts and the tightness of the contact resulting therefrom during any kind of pressure application. The volume of the pump chamber 80 is then reduced. The pressure of the enclosed liquid rapidly increases. It acts on one of the sealing lips 12, 14

on the pump piston 51. The position ~~of this~~ lip, directed downward and toward the pump cylinder 43, ensures that the pump chamber 80 is sealed off from the ambient air. In addition, the pump chamber 80, via longitudinally directed grooves 66 located in the outer wall of the piston skirt 17, communicates with a small clearance space 65 between the pump piston 51 and the skirt-type piston 16. The liquid consequently expands in this direction. Thus the same pressure is exerted on the lower end of the piston skirt 17 and on the upper side of the skirt-type piston 16, whose piston surface is larger. This results in forces parallel to the axis OO whose resultant tends to move the skirt-type piston 16 back into the interior of the pump cylinder 43. The valve rod 61 draws back from the valve seat 158. Thus the path to the outside via an outlet channel 94 and the nozzle 28 of the actuating device 90 is cleared for the liquid under pressure. The atomization takes place until the pressure of the liquid in the pump chamber 80 is no longer sufficient to keep the outlet valve 158, 162 open. In other words, this approximately corresponds to the end of the stroke of the skirt-type piston 16. The parts of the dosing pump therefore now assume the position shown in Fig. 2.

If the operator no longer exerts the force F on the actuating device 90, the helical compression spring 9 again presses the pump piston 51 and the skirt-type piston 16 upwardly in the pump housing 48. The volume of the pump chamber 80 correspondingly increases. Nonetheless, a connection to the interior of the container 26 is not made immediately. An appropriate passage 46 forms only when all movable parts 51, 16 and 90 have again assumed the position shown in Fig. 1. In the meantime, the pump chamber 80 increases without fresh liquid being fed. The liquid still remaining there after the atomization is consequently subjected to a vacuum. As long as the parts are sufficiently well adjusted relative to one another so that the pump chamber 80 is closed gas-tight in this transition phase, this results in a vigorous intake of liquid when the passage 46 is opened again. Venting the container 26 therefore enables the pump chamber 80 to be filled satisfactorily. However, as a result of the material fatigue, it is possible that the tightness of the seal produced between the pump piston 51 and the pump cylinder 43 is no longer guaranteed if a powerful vacuum prevails in the pump chamber 80. In this way, air could be drawn in via this seal. The vacuum is thereby considerably reduced so that, when the passage 46 is opened, only a relatively small quantity of liquid is supplied to the pump chamber 80. This quantity of liquid may possibly no longer correspond to the dosage quantity which the operator would like to atomize with the pump.

Figs. 3 to 5 show a dosing pump 20 according to the present invention. According to Fig. 3, the pump 20 is fixed in a conventional closure cap 22 which includes suitable means, e.g. a thread 24, for fixing the cap 22 together with the pump 20 fixed therein to the open upper side of a conventional container.

The container is filled with a liquid product (not visible below the pump 20 in the container 26 in Fig. 3). The liquid is drawn into the pump 20 through a conventional suction-tube or dip-tube nipple 30 which is connected to the under side of the pump 20 in a conventional manner. The dip tube (not shown) attached to the nipple 30 extends down near to the bottom of the container. The lower end of the suction tube is therefore normally immersed in the liquid when an associated container is orientated in a generally upright position.

The closure cap 22 has a generally cylindrical hollow wall 31, an inner cylindrical opening 32 being formed above and separately from the thread 24 by an annular flange 34 protruding inward. Attached inside the cap opening 32 is a holder 38 which has an outer wall 40 which, at its lower end, forms an annular flange 42 protruding outward. The annular flange 42 is firmly fastened and sealed off relative to the upper side of the container opening.

The holder 38 serves to fix the pump 20 inside the cap 22. For this purpose, the pump 20 comprises a housing 48 having an upper flange 50 protruding outward. The flange 50 is seized by a shoulder 56, protruding radially inward, on the outer wall 40 of the holder 38. The holder 38, in order to fix the pump housing 48, can easily be mounted with a snap seat onto the pump housing 48 and connected to it.

The pump housing 48 comprises an essentially cylindrical pump chamber 80 which is open at the top end, into which a cylindrical inner shell 72 of the holder 38 engages. The inner shell 72 is arranged coaxially to the outer wall 40 of the holder 38 and is connected to the latter at the upper end by an annular end wall 64. The inner shell 72 ends in a tapered lower end 73 inside the pump chamber 80.

The flange 50 on the upper end of the pump housing 48 is provided with a perpendicular groove 62, which is shown in the right-hand half of Fig. 3. The groove 62 forms an air-outlet slot between the pump housing 48 and the outer wall 40 of the holder 38 and interacts with certain vent channels in the holder 38. In particular, the upper annular end wall 64 forms an encircling groove 68 on the under side of the holder 38. The groove 68 is connected to the upper side of the groove 62, as shown in the right-hand half of the drawing. In a position offset by 180° relative to the groove 62, the groove 68 is connected to a radial groove 70

which is provided in the under side of the upper end wall 64 of the holder 38. The groove 70 extends inward past the wall of the pump housing 48.

The cylindrical inner shell 72 of the holder 38 is provided with a plurality of ribs 74 arranged at a distance apart over the circumference and protruding outward. The perpendicular outer surfaces of the ribs 74 bear against the inner wall of the pump housing 48 and serve to coaxially orientate the holder 38 and the pump housing 48.

The entire circumference of the upper inner margin of the pump housing 48 is widened conically upward at 75 in order to form an annular channel 71 around the holder 38 at the upper ends of the ribs 74. The intermediate spaces between the ribs 74 connect an annular space 77 below the ribs 74 at the lower end of the cylindrical inner shell 72 of the holder 38 to the annular channel 71 which runs around the upper ends of the ribs 74. This results in a vent channel which extends from the interior of the pump housing 48 out through the radial groove 70, around the circumferential groove 68, through the groove 62 passed the shoulder 56 and then down between the cylindrical outer wall 40 of the holder 38 and the pump housing 48 into the inner head space of the container above the liquid. This vent channel, together with other pump components, enables atmospheric air to enter into the container as described further below.

A pump piston 82 is mounted so as to be movable in a reciprocating and sealing manner in the pump chamber 80. The pump piston 82 is provided with a hollow-cylindrical stem 86 which extends upward and protrudes from the pump chamber 80 through the holder 38 passed the cap 22 to the outside. The cylindrical piston stem 86 serves to accommodate an actuating and delivery head or button 90 which is provided with a delivery port 92 which is connected to the upper end of the piston stem 86 by a radial outlet channel 94. Passing through the pump piston 82 as well as its stem 86 protruding upward is an axial outlet channel 98 which connects the outlet channels 94 inside the actuating head 90 to the pump chamber 80.

The outside of the piston stem 86 is tapered toward the upper end so that its diameter decreases with increasing height above the holder 38. The lower end of the pump piston 82 forms a sealing surface 102, concave toward the bottom, for the side surfaces of the lower end 73 of the inner shell 72 of the holder 38 to bear against and be sealed off when the pump piston 82 is located in the fully raised inactive position according to the left-hand half of Fig. 3. However, if the pump piston 82 is pressed down partly or essentially completely, the concave sealing surface 102 of the pump piston 82 comes away from the lower end 73 of the inner wall 72 of the holder 38. A clearance space is therefore created between the outside of the upper part, reduced in diameter, of the pump piston stem 86 moving downward and the lower end 73 of the inner shell 72 of the holder 38.

Consequently, ambient air can flow into the container in order to fill the volume of the sprayed contents and to maintain the atmospheric air pressure inside the container. In the process, ambient air flows into the cap opening 32 and also beneath the actuating head 90.

If the piston stem 86 is located in its lowered position, the air flows through an annular gap 23 passed the cylindrical inner shell 72 of the holder 38 and the pump housing 48. The air then passes through the radial groove 70 and into the circumferential groove 68. Here it disperses in both directions around the circumference of the holder 38 over about 180°, where it then flows through the groove 62 of the pump housing 48. The air then flows between the holder 38 and the pump housing 48 down into the container.

Via the suction-tube nipple 30 and a suction channel 248, liquid is fed to the pump chamber 80 through a fixed feedline which, in the preferred embodiment shown, consists of a cylindrical tubular feed piece 120 which protrudes from the base of the pump housing 48 up into the pump chamber 80 coaxially to the latter and has an open upper end 121.

A second differential piston is composed of two parts, namely a valve body 150 and a sealing sleeve 190. The valve body 150 is orientated axially above the fixed tubular feed piece 120 and is also arranged so as to be movable with and relative to the pump piston 82 above the tubular feed piece 120. The pump piston 82 encloses an enlarged bore 154 whose upper end leads into the outlet channel 98 of smaller diameter at a location which is formed by an annular valve seat 158. The valve body 150 is shaped at the upper end as a valve cone 162 which bears tightly against the annular valve seat 158 in the pump piston 82 in order to prevent liquid from flowing out of the pump chamber 80 through the outlet channel 98.

The lower end of the valve body 150 is designed as a valve head 170. The valve head 170 has an upper piston surface 172 which is provided with four ribs 174 which are separated by equal circumferential angles, extend radially outward and protrude up from the upper piston surface 172. The piston surface 172 of the valve head 170 is put under pressure by the liquid in the pump chamber 80, as described in detail below.

The under side of the valve head 170 is provided with an annular groove 179, trapezium in cross-section, and is an integral part of an inlet valve. For this purpose, the outer side wall of the

annular groove 179 forms a valve surface 180, widening conically downward and outward, for sealing against the upper conical contact surface 218 of the sealing sleeve 190 which is connected to the valve body 150 in such a way that it can be displaced axially to a limited extent. The valve surface 180 and the conical contact surface 218, with the center longitudinal axis O-O of the pump, form an essentially identical nose angle opening downward. The inner side wall of the annular groove 179 is formed by a cylindrical guide pin 230.

The guide pin 230 is provided with a plurality of longitudinal ribs 234, for example four, which are distributed over the circumference at the same distance apart each and, with lower end faces 235, partly rest on the upper end 241 of the helical compression spring 240. The longitudinal ribs 234, with longitudinal sections 236 whose radial height is adapted to the inside diameter of the helical spring 240 and is dimensioned to be correspondingly smaller, extend beyond their end face 235 into the upper end 241 of the helical spring 240.

The sealing sleeve 190, on its side facing the container, comprises an essentially cylindrical piston skirt 202. The upper end of the sealing sleeve 190 has an annular inner flange 210 whose under side forms a shoulder 211 which rests on the upper end 241 of the helical compression spring 240 when the pump piston 82 is located in its upper inactive position (Fig. 4). In this inactive position the inlet valve (passage 54) is open. The inner flange 210 can be axially displaced from this inactive position into an operating position in which the inlet valve is closed (Fig. 5). The inner flange 210 extends with its shoulder 211 and its upper front side 212 at right angles to the pump axis O-O as well as axially in the annular groove 179 of the valve head 170.

The helical compression spring 240 consists of a spring wire round in cross-section. It is apparent here that the upper end 241 of the spring 240, with the inner half of the spring-wire circumference, bears against the end face 235 of the longitudinal rib 234, that is, over an angle of contact of about 80°. The lower longitudinal sections 236 of the longitudinal ribs 234 protrude radially only by about 1/3 of the width of the longitudinal ribs 234. It will be understood that, facultatively, instead of a spring wire circular in cross-section, a spring wire of other cross-section, e.g. a rectangular cross-section, can also be used as long as it is ensured that the diameter of the spring wire is dimensioned to be larger than the radial width of the longitudinal ribs 234 so that part of the wire cross-section forms the support for the inner shoulder 211 of the sealing sleeve 190. At the same time, the end face 235 of the longitudinal ribs 234 should in each case be adapted to the cross-section of the spring wire. Finally, an arrangement, facultatively differing herefrom, can be made in such a way that a shim (not shown) is arranged between the upper end 241 of the helical compression spring 240 and the end face 235, in this case conveniently parallel to the inner shoulder 211, of the longitudinal ribs 234, which shim extends radially from the longitudinal sections 236 below the end faces 235 to below the inner shoulder 211 of the annular flange 210 of the sealing sleeve 190 and in this way forms a stop or supporting element for the latter. Facultatively, this shim can be firmly connected to the upper end 241 of the spring 240, whose cross-section in this case need not necessarily protrude radially beyond the longitudinal ribs 234.

As a result of the lower abutment, formed by the upper end 241 of the helical compression spring 240, for the sealing sleeve 190, a clearance space is created which enables limited axial movement between the valve body 150 and the sealing sleeve 190. Here, this relative mobility of the sealing sleeve 190 is arranged in such a way that the contact surface 218 of the sealing sleeve 190 bears against the inner valve surface 180 of the outer margin 171 of the valve head 170 in the one end position of the relative motional range of the sealing sleeve 190 so that the inlet valve formed by the said parts is closed. The circumstances under which this relative movement from one end position to the other end position occurs will be described in greater detail further below.

The piston skirt 202 of the sealing sleeve 190 is provided with guide ribs 250 which protrude outward and are distributed at a distance apart over the circumference and with which the sealing sleeve 190 slides along the inner wall of the pump chamber 80 in order to maintain the axial orientation of the sealing sleeve 190 inside the pump chamber 80 as well as relative to the tubular feed piece 120.

The inner flange 210 of the sealing sleeve 190 encloses a cylindrical opening 226. Liquid can flow through this opening 226 to refill the pump chamber 80 during a certain operating state of the pump, which will be described below. Air or vapors can likewise flow in the reverse direction through the opening 226 during the venting of the pump chamber 80 to make it possible to prime the pump. The opening 226 also accommodates the guide pin 230 for the upper end 241 of the helical compression spring 240, which guide pin 230 extends down from the valve head 170 coaxially to the main axis of the pump.

The lower end of the sealing sleeve 190 is designed in such a way that it can slide down telescope-like in a sealing manner in tight contact along the outer surface of the fixed tubular feed

piece 120. For this purpose, the lower end of the sealing sleeve 190 is provided with an annular beading 260, protruding inward, for bearing against the outer side of the tubular feed piece 120 when the movable sealing sleeve 190 moves down, as will be explained below.

Fig. 5 shows in correspondence with the right-hand half in Fig. 3 the upper end position of the sealing sleeve 190 relative to the valve body 150 and the outer margin 171 of the valve head 170. The upper frustoconical contact face 218 of the sealing sleeve 190 here bears tightly against an appropriately angled conical valve face 180, so that a connecting channel, to be seen in Fig. 7 is closed.

According to Fig. 3, the spring 240, with its lower end, is supported inside the pump chamber 80 on the base 49 and, inside the tubular feed piece 120, overlaps a lower guide pin 246 which is coaxial to the main axis of the pump and protrudes up from the housing base. The guide pin 246 is an integral part of the pump housing 48 and forms the inlet channel 248 which makes the connection between the dip tube (not shown) and the tubular feed piece 120. It is apparent that the spring 240 normally pretensions the valve body 150, together with the pump piston 82 bearing thereon, in a fully raised position when the pump is located in its unactuated inactive position (left-hand half of Fig. 3 and Fig. 5).

The valve head 170, at the circumference of its margin 171 extending downward and outward like a truncated cone, is provided with a plurality of ribs 194 which are arranged at a distance from one another over the circumference, extend down along the inner wall of the pump housing 48 and help to axially guide the valve body 150.

The components of the pump 20 which are described above can be made of thermoplastic materials. However, the spring 240 is preferably made of stainless steel. The pump housing 48, including the fixed tubular feed piece 120, is conveniently made of polypropylene. Other internal components, e.g. the pump piston 82, the valve body 150 and the sealing sleeve 190 or parts of these other components can be made of polyethylene in order to obtain a better sealing effect.

The components of the pump can easily be assembled. First of all the internal components of the pump are assembled, and then the suction tube (not shown) is attached to the suction-tube nipple 30 of the pump housing 48 in a conventional manner.

On account of the axially limited mobility relative to the valve body 150, the movable sealing sleeve 190 can immediately be pushed onto the guide pin 230 of the valve body 150 without contacting other parts or overcoming flexible claws, whereupon the upper end of the helical compression spring 240 is pushed onto the guide pin 230, and the sealing sleeve 190 is thereby held so as to be axially movable to a limited extent on the valve body 150.

The assembled sealing sleeve 190 and valve body 150 are then easily seated within the pump piston 82 and its stem 86, and the three components are inserted together with the spring 240 into the pump chamber 80 of the pump housing 48.

The holder 38 is seated on top of the pump housing 48 around the piston stem 86, and the cap 22 is mounted around the holder 38.

Mounting the actuating head 90 onto the upper end of the piston stem 86 completes the assembly of the pump 20, which can then be attached to the neck of a container.

If the dosing pump according to the invention is in the inactive state, the sealing sleeve 190, with regard to the valve head 170, assumes the end position shown in Fig. 4. The force F exerted by the operator during actuation of the pump leads to the compression of the return spring 240 so that the pump piston 82 and the valve body 150 move down inside the pump housing 48. The sealing sleeve 190 briefly follows this movement, while the inner flange 210, with its shoulder 211, is supported on the return spring 240. However, when the lower free end of the sealing sleeve 190 strikes the tubular feed piece 120, the movement of the sealing sleeve is briefly interrupted. However, the upper end of the sealing sleeve 190 stopped briefly at the tubular feed piece 120 is quickly reached by the valve head 170 so that both parts assume the closed position in Fig. 5. From this moment on, the valve head 170 guides the sealing sleeve 190 down with it so that the sealing sleeve 190 slides telescope-like in a sealing manner over the tubular feed piece 120. The friction resulting therefrom contributes to a relative pressure of the inner flange 210 on the annular groove 179 so that the connecting channel 54 between the contact surface 218 of the sealing sleeve 190 and the valve surface 180 of the valve head 170 is closed or sealed off. From this moment on, which, moreover, commences just after the start of the pump actuation, the pump chamber 80 is completely closed off. Pressing the pump piston 82 down further now causes the pressure to increase in the pump chamber 80.

However, it has to be pointed out that this behavior critically depends on the selection of that point at which the inner flange 210 is supported on the valve body 150. This is because, as long as the pressure P in the pump chamber 45 increases, an axial force directed outward is added to the abovementioned friction between the sealing sleeve and the guide pin. If s is the cross-sectional area of the ribbed groove which extends from the inner

surface of the piston skirt 202 of the sealing sleeve 190 to the inner wall of the pump chamber 80 (Fig. 3), the force is obtained from the product of s and P. If P is even increased only slightly, the force far exceeds the friction of the sealing sleeve 190 at the tubular feed piece 120 and is consequently critical for the tight closure of the connecting channel 54. If this connecting channel 54 is at such a distance from the main axis OO of the dosing pump that an annular area having the cross-section S is accessible to the liquid, under the pressure P, between the bearing surface of the sealing sleeve 190 on the valve body 150 and the inner wall of the pump cylinder 43, an axial force SP develops which is directed toward the container, counteracts the force sP and tends to thrust back the sealing sleeve 190 and open the connecting channel 54. It must therefore be ensured without fail that S is smaller than s. During the pressurizing of the pump chamber 80, the connecting channel 54 remains closed all the better the smaller S is in relation to s. The embodiment shown in the figures is thus optimum insofar as S equals 0. In this phase of the pump compression, all actions consequently take place as if the sealing sleeve 190 and the valve body 150 were inseparably connected to one another. The liquid enclosed in the pump chamber 80 is then discharged as in known pumps.

However, this analogy no longer applies to the following operating phases of the pump. As soon as the force F is no longer applied, the return spring 240 presses the valve body 150 back. The valve body 150 thus moves away from the sealing sleeve 190, which is held in place as a result of the friction at the tubular feed piece 120. The sealing sleeve thus moves from the closed position shown in Fig. 5 into the open position according to Fig. 4. The connecting channel 54 between the valve head 170 and the inner flange 210 of the sealing sleeve 190 is open and therefore makes a connection between the container and the pump chamber 80 via the intermediate spaces or grooves located between the longitudinal ribs 250. The return spring 240, on which the inner shoulder 211 of the inner flange 210 now rests, now takes the valve body 150 up with it at the same time as the sealing sleeve 190. This results in an increase in volume in the pump chamber 80. Since the connecting channel 54 is open, liquid is let into the pump chamber 80 along the path identified by arrows in Fig. 4. The connecting channel 54 is adequate to enable the pump chamber 80 to be filled to the extent by which the volume of the pump chamber 80 increases. If the dosing pump 20 has thus returned fully into the initial or inactive position and the passage 46 between the free lower end of the sealing sleeve 190 and the upper end 121 of the tubular feed piece 120 is restored, no more liquid is drawn in through the tubular feed piece 120. Theoretically, therefore, the passage 46 would be dispensable. However, this would mean that a gastigth contact between the tubular feed piece 120 and the end of the sealing sleeve 190 would have to be continuously maintained,the quality of which would inevitably deteriorate on account of the plastic flow of the plastic parts.

When the dosing pump according to the present invention is actuated, the connecting channel 54 therefore closes approximately at the same moment at which the passage 46 is interrupted. But, when the pump piston 82 moves upwardly connecting channel 54 opens before passage 46 is restored. A distinctly weaker vacuum therefore arises in the pump chamber 80. Consequently, only a little air, if at all, can enter, even if the seal of the pump piston 82 relative to the pump cylinder 43 should no longer close particularly tightly. In particular, the pump piston 82 here only needs the single sealing lip 14, as shown by Fig. 3. The remaining single sealing lip 14 is directed toward the container so that, during the discharge phase of the liquid, the pressure prevailing in the pump chamber 80 further increases the sealing effect. Dispensing with one of the two sealing lips reduces the friction of the pump piston 82 on the pump cylinder 43 by half. The spring 240 therefore no longer needs to be so powerful as hitherto in order to move the pump piston 82 and the valve body 150 up again. The operator, who compresses the return spring 240 during the downward movement of the pump piston 82, must therefore apply less force F, which is in more favorable proportion to the strength of a child's finger. All these advantages are achieved with an additional part, namely the sealing sleeve 190, which represents a separately product part. This improves the quality of the atomization, which secures the discharge of a uniform dosage quantity virtually irrespective of the age of the dosing pump.

The two mating parts 150 and 190 of the differential piston thus interact through the return spring 240 and thus enable the liquid to be drawn in during actuation of the dosing pump. When the pump chamber 80 is filled with air, which as a rule is the case when the dosing pump is actuated for the first time, the pressure in the pump chamber 80, by the downward movement of the movable parts 82, 150, 190 inside the pump housing 48, does not increase to such an extent that the outlet valve 158, 162 could be opened. During the upward movement of conventional pistons, the vacuum required for the admission of liquid is thus not present in the pump chamber 80. This disadvantage, which the known dosing pumps compensate for with various devices, is dispensed with in dosing pumps which are equipped according to the

invention. The connecting channel 54 between the pump chamber 80 and the container 26 opens at the very beginning of the upward movement of the pump piston 82, as a result of which the air can disperse again by again flowing along the path identified by arrows in Fig. 4 but this time in the opposite direction to that of the arrows. In this way, air passes from the pump chamber 80 into the container. In the course of the further upward movement of the pump piston 82, simply the increase in volume in the pump chamber 82 consequently produces a vacuum which can, as desired, draw liquid into the pump chamber 80 and fill the latter with liquid.

This method of construction can just as easily be used in absolutely tight atomizers in which air must on no account be allowed to penetrate, since, for example, the liquid in the container will oxidize. In this case, a certain quantity of a compressed inert gas is first introduced above the liquid. In addition, the holder 38 has grooves for venting purposes. Here, filling of the pump chamber 80 is made possible by the expansion of the gas.

List of reference numerals

OO Rotational axis
9 Return spring
12 Sealing lip
14 Sealing lip
16 Skirt-type piston
17 Piston skirt
18 Annular space
20 Dosing pump
22 Closure cap
23 Annular gap
24 Thread
26 Container
28 Nozzle
30 Dip-tube nipple
31 Wall
32 Cap opening
33 Annular gap
34 Annular flange
38 Holder
40 Outer wall
41 Seal
42 Annular flange
43 Pump cylinder
44 Guide pin
45 Annular space
46 Passage
48 Pump housing
49 Housing base
50 Flange
51 Pump piston
54 Connecting channel
55 Recesses
56 Shoulder
61 Valve rod
62 Groove
64 End wall
65 Clearance space
66 Grooves
68 Circumferential groove
70 Radial groove
71 Annular channel
72 Inner shell
73 Lower end
74 Ribs
75 Conical widening
77 Annular space
80 Pump chamber
82 Pump piston
86 Piston stem
90 Actuating head
92 Spray port
94 Outlet channel
98 Outlet channel
102 Sealing surface
120 Tubular feed piece
121 Upper end
150 Valve body
154 Bore
158 Valve seat
162 Valve cone
170 Valve head
171 Outer margin
172 Upper piston surface
174 Ribs
179 Annular groove
180 Conical valve surface
190 Sealing sleeve
194 Ribs
202 Piston skirt
210 Inner flange
211 Shoulder
212 End face
218 Contact surface
222 Upper cross wall
226 Opening
230 Guide pin
234 Longitudinal ribs
235 Lower end face
236 Longitudinal sections
240 Return spring, helical compression spring
241 Upper end
246 Lower guide pin
248 Suction channel
250 Guide ribs
260 Annular beading

Claims

1. A dosing pump for atomizing a liquid, which dosing pump is contained in a container and in which the following parts are arranged on a common rotational axis:

- a pump housing (48) is connected to the container by a cylindrical, open tubular feed piece (120) which extends into the interior of the pump housing (48),
- a first hollow pump piston (82) is displaceably arranged in the interior of the pump housing (48), the pump piston (82), to seal off a pump chamber (80) in the interior of the pump housing (48) from the atmosphere, bearing tightly against the inner wall of the pump housing (48) as well as being provided, on the side remote from the container, with a hollow piston stem (86) having a narrowed inner cross-section of an axial outlet channel (98) as a valve seat (158),
- a second differential piston which is displaceably arranged in the interior of the pump housing (48) and, on the side facing the container, is provided with a piston skirt (202) whose one free end can be pushed in a sealing manner onto the open tubular feed piece (120) of the pump housing (48) to close the pump chamber (80) from the container, and, on the side remote from the container, with a valve rod (162), engages into the hollow piston stem (86) of the pump piston (82) and interacts with the valve seat (158) located therein to form an outlet valve for the delivery of the liquid contained in the pump chamber (80) into the atmosphere,
- a return spring (240) which is arranged between the differential piston and the pump housing (48) and which overlaps a guide pin (230) and bears against the latter, which is provided on the side of the differential piston facing the container, the differential piston consisting of two parts (150, 190), of which one part has the piston skirt (202) and, with the tubular feed piece (120), forms an inlet valve for the liquid flowing from the container into the pump chamber (80),

wherein the two parts (150, 190) of the differential piston interact through an interposed return spring (240).

2. The dosing pump as claimed in claim 1, wherein the part (190) of the differential piston provided with the piston skirt (202) has an inner flange (210) having a free end and an inner surface (226) which is displaceable between a closed position of the inlet valve and an open position of the inlet valve on longitudinal ribs (234) protruding from the guide pin (230), wherein the guide pin (230) on the other (150) of the two parts of the differential piston is supported by the return spring (240), overlapping the longitudinal ribs (234) of the guide pin (230) and bearing against the latter, the inner flange (210) being held in the open position of the inlet valve by the return spring (240), and the free end of the inner flange (210) bearing against the other (150) of the two parts in the closed position of the inlet valve at a distance from the rotational axis (OO) which is dimensioned to be greater than the inner radius of the piston skirt (202).

3. The dosing pump as claimed in claim 2, wherein the return spring (240) protrudes radially outward beyond the longitudinal ribs (234) of the guide pin (230) in such a way that it forms a stop for the inner flange (210) in the open position of the inlet valve.

4. The dosing pump as claimed in either of claims 2 or 3, wherein the longitudinal ribs (234) on the guide pin (230), with longitudinal sections (236) whose radial height is adapted to the inside diameter of the return spring (240), extend past the end face (235) formed by them into the upper end (241) of the return spring (240).

5. The dosing pump as claimed in claim 2, wherein a ring is arranged between the guide pin (230) and the piston skirt (202) and is connected between the spring (240) and the longitudinal ribs (234), the ring protruding radially downward beyond the guide ribs (234) while forming a stop for the inner flange (210) in the open position of the inlet valve.

6. The dosing pump as claimed in any of claims 2 to 5, wherein the free outer end of the inner flange (210) has a chamfered contact surface (218) and abuts against the other part (150) in the closed position of the inlet valve at a level of the contact surface (218), the other (150) of the two parts (150, 190) having an outer valve surface (180) which forms an annular groove (179) into which the inner flange (210) engages.

7. The dosing pump as claimed in claim 6, wherein, in the closed position of the inlet valve, the contact surface (180) is arranged at a distance from the base of the annular groove (179).

8. The dosing pump as claimed in any of claims 2 to 7, wherein four longitudinal ribs (234) are arranged at equal circumferential distances on the outer side of the guide pin (230).

9. The dosing pump as claimed in any of claims 1 to 8, wherein the pump piston (82) is provided with a single sealing lip (14) which faces the container and bears tightly against the wall of the pump chamber (80) of the pump housing (48).

10. The dosing pump as claimed in claim 9, wherein the return spring (240) is dimensioned so as to be more powerful than the friction of the sealing lip (14) of the pump piston (82) and the friction of the piston skirt (202) of the differential piston (190) at the tubular feed piece (120) of the pump housing (48).

Fig. 1

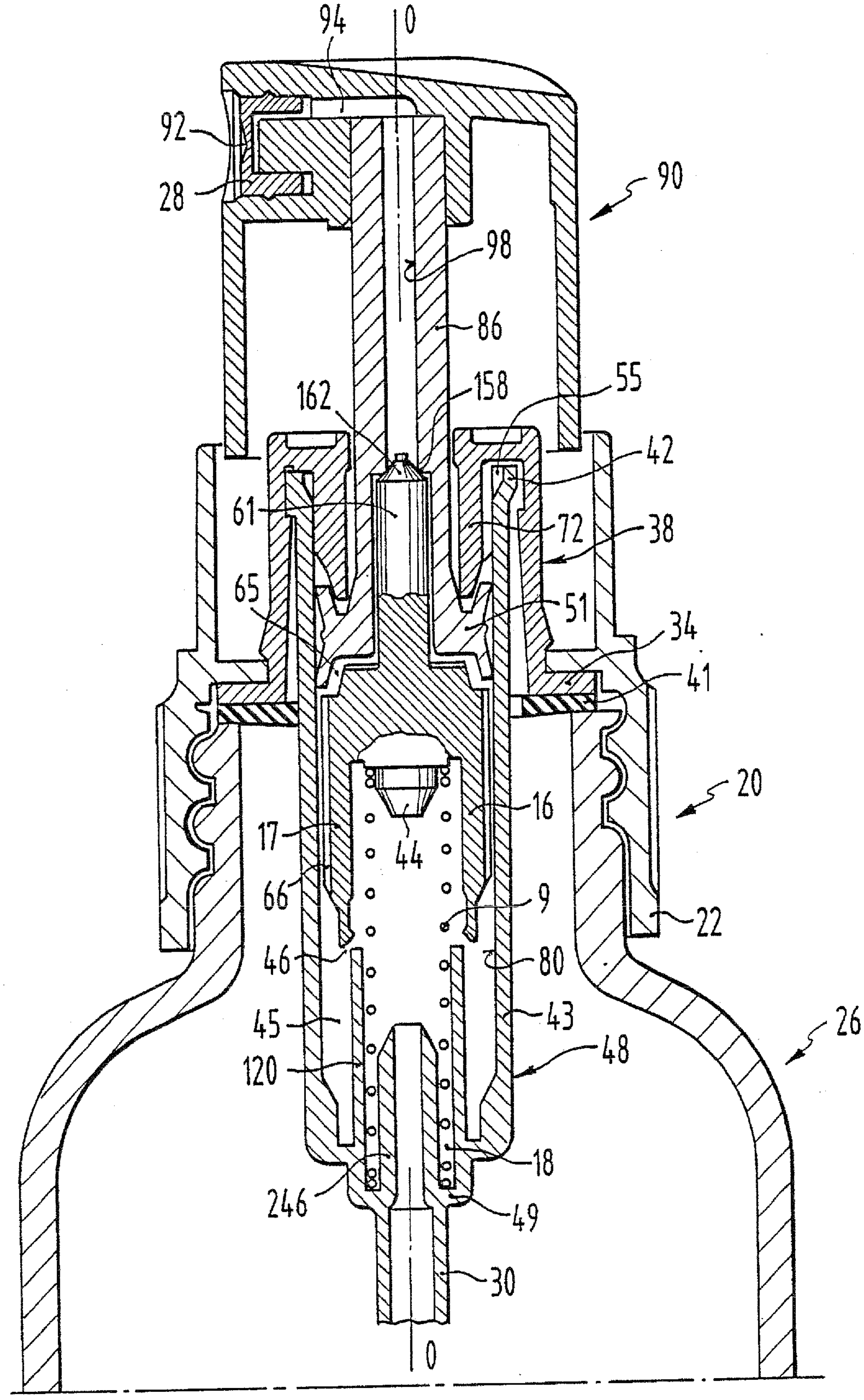

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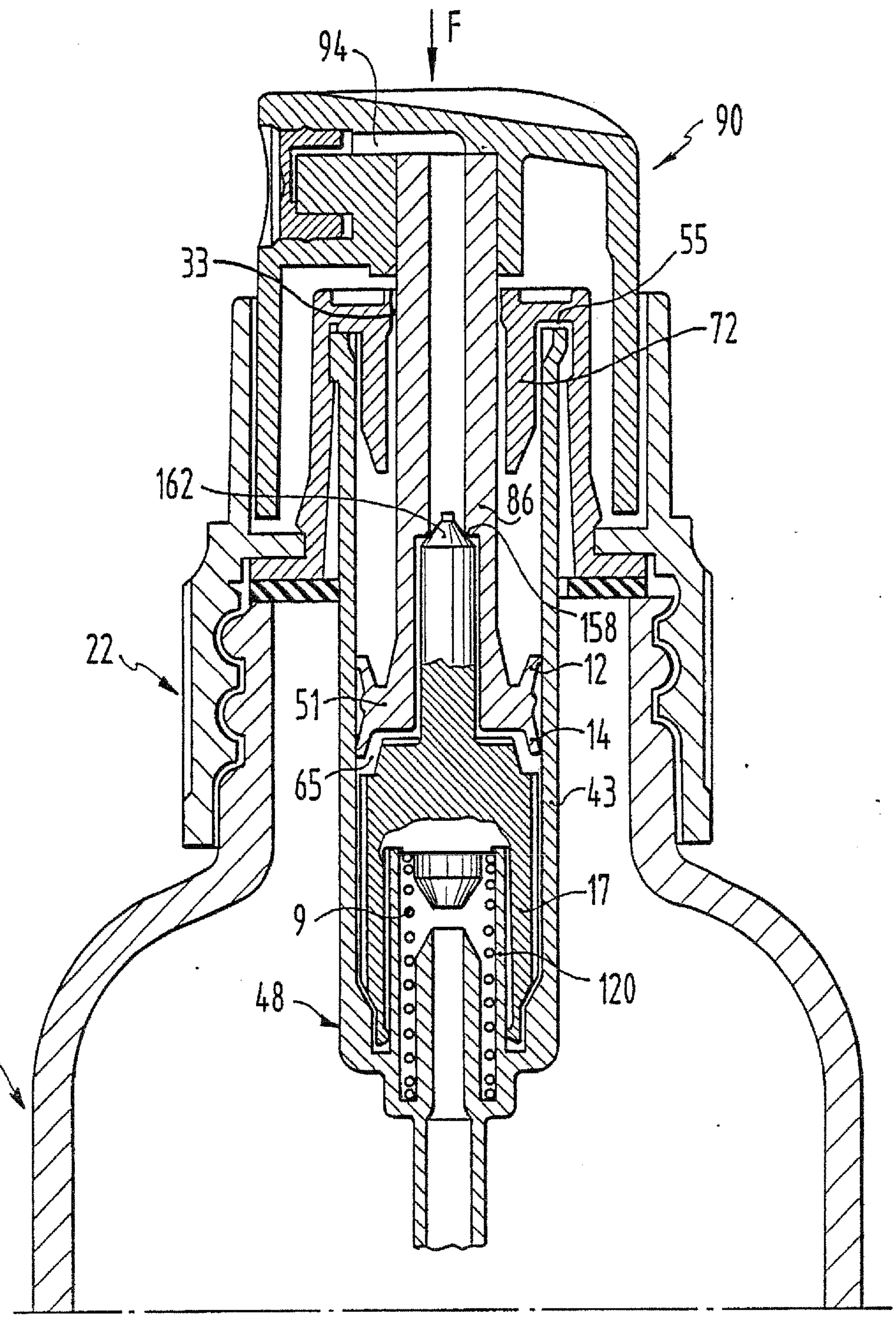
Fig. 2



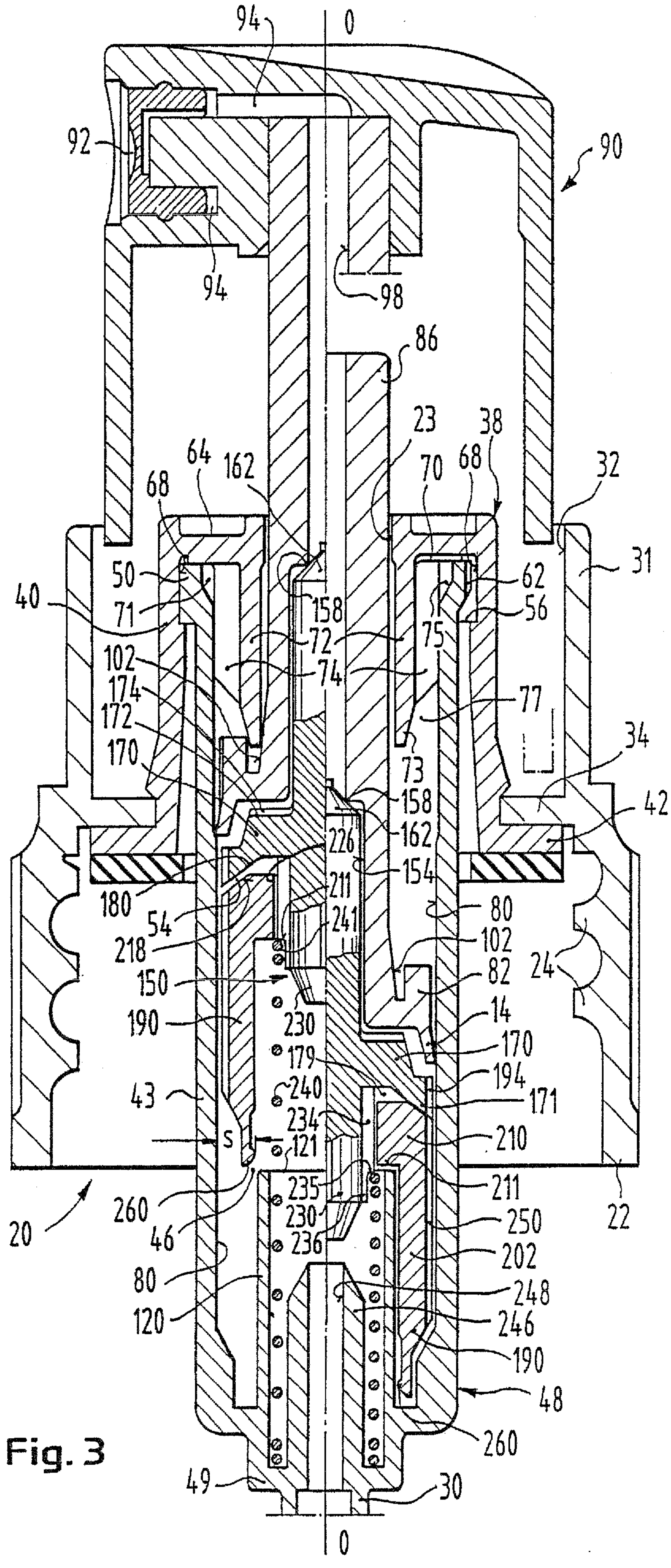


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Fig. 3

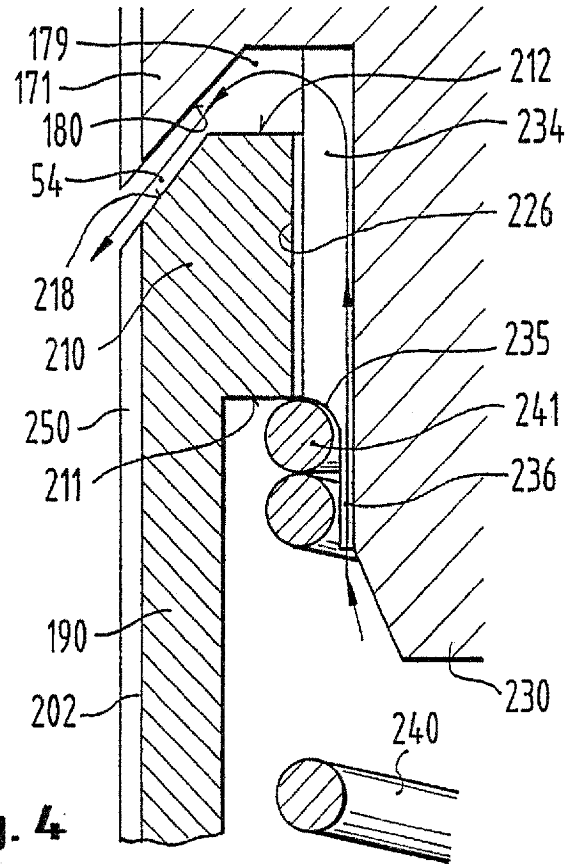
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Fig. 4

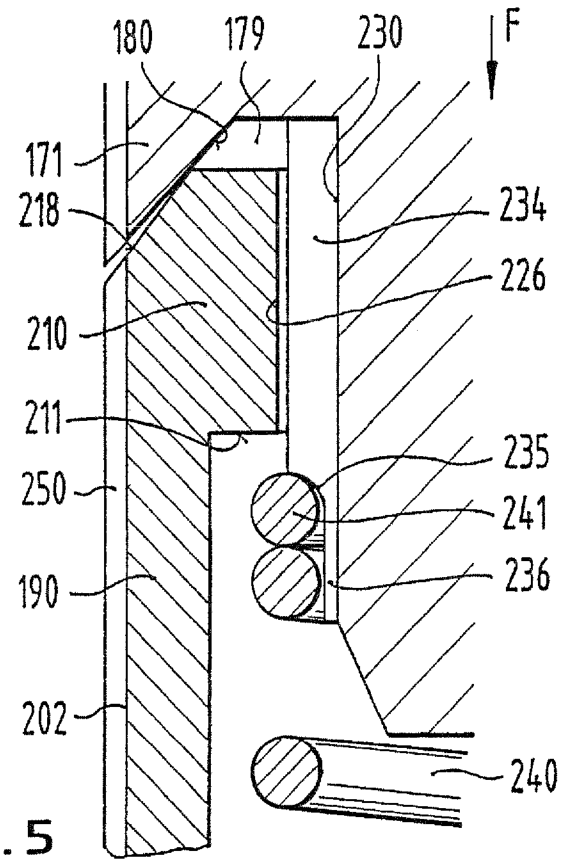
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Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 10 8879

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
P,D A	EP-A-0 289 855 (E. PFEIFFER GmbH) * Whole document *	1,6,7	B 05 B 11/00
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			B 05 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24-07-1989	JUGUET J.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
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